

## **REMARKS / ARGUMENTS**

### ***In the Claims***

Claims 1-16 were pending in the present Application. New claims 17-20 have been added, so that now claims 1-20 are pending in the Application.

Claims 1, 2, 4, 5, 7, 9, 11, 12 and 14-16 have been amended. The claim amendments have not been made for purposes of patentability over the cited prior art. Rather, the amendments have been made to improve the clarity of the claims.

In particular, independent claims 1, 5, 7, 11, 12 and 15 have been amended to clarify that the laser gating signals cause the laser to generate the photon signals, and that the detected photon signals are encoded by the encoding stations prior to being detected, as described in at least paragraphs [0027] through [0034] of the Applicants' Published Application. Amendments to dependent claims 2, 4 and 14 correct minor language problems.

New claims 17 and 18 depends from claim 1 and includes limitations directed to the phase modulations performed in the first and second encoding stations, as described in at least paragraphs [0027] through [0034] of the Published Application. New claims 19 and 20 depend respectively from claims 12 and 15 and are directed to a two-way QKD system embodiment where the laser and SPD unit reside in the same QKD encoding station (Bob), as described in at least paragraphs [0027] through [0034] and as shown in FIG. 1 of the Published Application.

### **Claim Objections**

Claims 2, 14 and 16 are objected to because they use the term "and/or." These claims have been amended to remove this term. Accordingly, withdrawal of the objection to these is respectfully requested.

### **Rejection under 35 USC §101**

Claims 5, 6 and 11 stand rejected under 35 USC §101 as being directed to non-statutory subject matter "of software, per se." The Examiner states the claims

lack “the necessary physical articles to constitute a machine or manufacture,” and that they “fail to declare that the ‘computer-readable medium causing a computer to execute instructions’ terminology that the courts have insisted upon.”

Applicants respectfully traverse this rejection.

Claim 5 includes the following preamble (emphasis added):

**A computer-readable medium** having **instructions embodied therein** to **direct a computer** in a quantum key distribution (QKD) system having first and second encoding stations and a laser **to perform the following method** of autocalibrating the QKD system:

Claim 11 includes essentially the same preamble language, and claim 6 depends from claim 5.

The above preamble language used by the Applicants is **entirely consistent** with the terminology required by the courts for claims directed to software-related inventions, and so cannot serve as a basis for rejecting the claims under 35 USC §101. See, e.g., *In re Beauregard*, 35 USPQ2d 1383, 1384 (Fed. Cir. 1995) (“The Commissioner now states ‘that computer programs embodied in a tangible medium, such as floppy diskettes, are patentable subject matter under 35 USC section 101 and must be examined under 35 USC §§102 and 103”).

The Examiner also points to a lack of “physical articles” in the claims. Yet, a closer reading of the claims reveals that all of the relevant physical articles to support the claim are present—namely, a QKD system, a laser, a computer and a SPD unit. Further, the independent claims have been amended to include more details about the operation of the QKD system when carrying out the method.

There is absolutely no confusion to one skilled in the art that the claimed methods apply to the operation of a QKD system “machine.” Further, there is no requirement under 35 USC §101 that such claims need include **every** “physical article” of the particular machine being considered. Only those physical articles relevant to the invention at hand are required to be included as claim limitations.

It is manifestly clear from the claim language that the claimed method is not

set forth in “non-function descriptive material,” but rather is set forth in concrete and definite terms that yield **physical results** in a **QKD system** — the results being a) the **determination** of an **optimal arrival time**  $T_{MAX}$  of the laser gating signals that corresponds to an **optimum number of photon counts** from an **SPD unit**, and b) the **dithering** of the **arrival time**  $T$  of the laser gating signals to **maintain the optimum number of photon counts**. This allows the **QKD system** to be **autocalibrated**—which is the ultimate physical result of the various intermediate physical results of a) and b), above.

In view of the concrete physical attributes set forth in claims 5, 6 and 11, and the physical results obtained therein, Applicants respectfully submit that these claims clearly constitute statutory subject matter under 35 USC §101, and respectfully request that the rejection of these claims be withdrawn.

#### **Non-Statutory Obviousness-Type Double-Patenting Rejection**

Claims 1, 5 and 7 stand provisionally rejected on the ground of non-statutory obviousness-type double patenting as being unpatentable over claims 1, 6 and 7 of co-pending Application No. 10/578,155.

A Terminal Disclaimer and fee is provided herewith that obviates the non-statutory obviousness-type double patenting rejection, and Applicants respectfully request the withdrawal of the rejection.

#### **Rejection under 35 USC §112**

Claims 7-10 stand rejected under 35 USC §112, second paragraph, for indefiniteness.

Claim 7 has been amended so that the method is directed to exchanging **photon signals** rather than **exchanging keys**. Applicants submit that this amendment to claim 7 renders definite claim 7 and claims 8-10 depending therefrom, and respectfully request withdrawal of the rejection of these claims.

## Rejection under 35 USC §102

Claims 1-16 stand rejected under 35 USC §102 as being anticipated by the article by Bethune and Risk, entitled “An autocompensating fiber-optic quantum cryptography system based on polarization splitting of light,” hereinafter referred to as “Bethune.”

Applicants note here that independent claims 1, 5, 11, 12 and 15 include the same main claim limitations directed to performing “laser gate scanning” and “laser gate dithering,” so that the comments below apply generally to all of Applicants’ pending claims.

A rejection under 35 USC §102 for anticipation requires that every claim limitation be found in the cited reference.

Applicant respectfully submits that the Examiner has adopted an overly expansive view of the nature and scope of the disclosure of Bethune. A closer reading of Bethune reveals that his approach to autocompensation is completely different than that of Applicants’ claimed invention, and that an anticipation rejection of the claims based on Bethune is inapt because Bethune does not teach all of Applicants’ claim limitations.

By way of review, Bethune is directed to (emphasis added) “a system for quantum key distribution (QKD) ... that ***passively compensates*** for time-dependent variations in the fiber-optic path due to stress, temperature or bi-refrindexence.” See *Abstract*, page 340, col. 1, lines 1-5; *Conclusion*, page 346, col. 2, lines 1-4. The teaching of Bethune is directed to a QKD system that has a very specific detector configuration that utilizes a very specialized circuit for pulse-biasing the particular type of single-photon detector used.

As described in the section entitled “*B. Single Photon Detection*” starting on page 342, col. 2, Bethune discusses how he makes use of a particular type of single-photon detector, namely a reversed-biased avalanche photodiode (APD), where the reverse bias is set to be above the reverse breakdown voltage. To reduce the rate of thermally triggered avalanche breakdowns, the detectors are cooled and are pulse-biased above breakdown for as short an interval as possible by providing very

short electrical pulses to the detector (e.g., 3.3 volt bias pulses of 1.5 ns in duration). Bethune uses a specially designed circuit (shown in Fig. 2(a)) that allows for short bias times and reliable detection of small photon-induced charge pulses through the use of two bias pulses. This in turn allows for a single APD to be used to monitor photons arriving in coincidence with either of the two bias pulses.

Note that the bias pulses are provided to the **detector**, i.e., the APD. The plot of Fig. 3(a) plots the detector “Count Rate” versus the bias pulse delay (ns). Here, the “bias pulse delay” is the (time) difference between the **electronic bias pulse** and the **photon arrival time**. The plot simply shows that a bias pulse delay of about 37 ns gives a maximum detector count rate. Said differently, providing a bias pulse to the detector 37 ns after the expected photon arrival time provides the best detection for the given SPD arrangement.

Applicants note here that the Examiner misinterprets Fig. 3(a) when he associates it with the Applicants’ claim limitation relating to varying the timing of the **laser gate signal** provided to the **laser**. In actuality, the plot of Fig 3(a) applies only to the **limited case** of providing a bias pulse to an **APD-type detector** that is connected to **highly specialized bias-pulse circuitry**.

Applicants’ claims do not include any limitations that the SPD be subject to a bias pulse, or that the SPD unit include an APD-type detector. In fact, in Applicant’s invention, and APD-type detector can be used **without the bias pulses and without the accompanying specialize circuitry of Bethune**.

Rather, Applicants’ claimed invention uses **laser gating signals** provided to the **laser** to generate the photon signals. The “arrival time T” of the laser gating signals is varied over a first range R1 to determine an optimal arrival time  $T_{MAX}$  that corresponds to a first optimum number of photon counts from the SPD unit for the encoded photon signals detected by the SPD unit. This is not taught in Bethune.

Applicants’ claimed invention also calls for **dithering the laser gate signal** by varying the arrival time T over a second range surrounding  $T_{MAX}$  to maintain either the first optimum number of photon counts or a second optimum number of photon counts. Again, there is **no teaching** in Bethune directed to **controlling the timing of the laser gate signals to maintain an optimum number of photon counts**.

Applicants' claimed invention **actively** maintains QKD system performance (and can be said to **actively** compensate the QKD system) by scanning the laser gate signal arrival time over a first time interval and then dithering the laser gate signal over a second time interval. In contrast, in Bethune **no active compensation is required**. See, e.g., Conclusion, page 346, col. 2, lines 1-4). Thus, by definition, Bethune cannot be said to teach such active scanning and dithering steps related to the operation of the laser in a QKD system.

In view of the above, Applicants respectfully submit that Bethune cannot reasonably be said to teach all of the claim limitations in Applicants' pending claims and so cannot be said to anticipate Applicants' claimed invention. Applicants therefore respectfully request the withdrawal of the anticipation rejection under 35 USC §102(b) of claims 1-16, and the allowance of pending claims 1-20.

## CONCLUSION

Claims 2, 14 and 16 have been amended to overcome the objection to these claims, and withdrawal of the objection is respectfully requested.

Applicants respectfully submit that, for the reasons stated above, Claims 5, 6 and 11 clearly constitute statutory subject matter under 35 USC §101 and respectfully request that the non-statutory subject matter rejection be withdrawn.

A Terminal Disclaimer is provided herewith that obviates the non-statutory obviousness-type double patenting rejection, and acceptance and entry of the Terminal Disclaimer is earnestly requested.

Claims 7-10 have been amended to overcome the rejection based on 35 USC § 112, second paragraph, for indefiniteness, and withdrawal of the indefiniteness rejection is respectfully requested.

Applicants respectfully submit that claims 1-20 as presently presented are patentable over the cited art of Bethune, and withdrawal of the anticipation rejection under 35 USC 102(b) and the issuance in due course of a Notice of Allowance for the pending claims is respectfully requested.

The Examiner is encouraged to contact the Assignee's authorized representative at 941-378-2744 to discuss any questions that may arise in connection with this Reply.

Respectfully Submitted,

By: \_\_\_\_\_ Date: December 03, 2008

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